AL-TP-1992-0049

ARMSTRONG LABORATORY

THE USE OF SMALL GROUPS IN COMPUTER-BASED TRAINING: A REVIEW WITH IMPLICATIONS FOR DISTANCE LEARNING

Stanley D. Stephenson

Department of Computer Information Systems
and Administrative Sciences
Southwest Texas State University
San Marcos, TX 78666

HUMAN RESOURCES DIRECTORATE
TECHNICAL TRAINING RESEARCH DIVISION
Brooks Air Force Base, TX 78235-5000

October 1992

Interim Technical Paper for Period June 1992 - August 1992

Approved for public release; distribution is unlimited.

AIR FORCE MATERIEL COMMAND
BROOKS AIR FORCE BASE, TEXAS 78235-5000

NOTICES

This paper has been reviewed and is approved for publication.

SHARON K. GARCIA
Contract Monitor

HENDRICK W. RUCK, Technical Director
Technical Training Research Division

RODGER D. BALLENTINE, Colonel, USAF
Chief, Technical Training Research Division

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	October 1992	Interim - June 1992 – August 1992

4. TITLE AND SUBTITLE

The Use of Small Groups in Computer-Based Training: A Review with Implications for Distance Learning

5. FUNDING NUMBERS

C - F49620-90-C-0076
PE - 62205F
PR - 1121
TA - 10
WU - 66

6. AUTHOR(S)

Stanley D. Stephenson

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Department of Computer Information Systems and Administrative Sciences
Southwest Texas State University
San Marcos, TX 78666

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Armstrong Laboratory
Human Resources Directorate
Technical Training Research Division
Brooks Air Force Base, TX 78235-5000

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

AL-TP-1992-0049

11. SUPPLEMENTARY NOTES

Armstrong Laboratory Technical Monitor: Ms Sharon K. Garcia, (512) 536-2981

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

The majority of studies investigating individual versus small group achievement within the computer-based training (CBT) framework have found no significant differences between the two experimental groups. Some studies produced significantly positive results, but no study produced significantly negative results. However, one would expect groups to outperform individuals. After reviewing the small group CBT literature, this paper suggests that in past studies, the behavior of the students in the small groups has not been appropriately structured. Based on related traditional instruction research, it appears that guiding students' behavior/discussions following CBT may increase achievement. A reciprocal peer-questioning model is proposed to provide this type of guidance. This model is briefly described and research is suggested. Implications of this model for distance learning are also provided.

14. SUBJECT TERMS

CBT
Computer-based training
Distance learning
Group training
Paired training
Reciprocal peer-questioning model

15. NUMBER OF PAGES

30

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18
298-102

TABLE OF CONTENTS

LIST OF TABLES

PREFACE

This paper summarizes work I performed under the 1992 Armstrong Laboratory's Summer Faculty Research Fellow program. I would like to thank the Armstrong Laboratory's Instructional Design Branch (HRTC) for giving me the opportunity to work on this project; it has been a most productive summer.

I would also like to extend a very special thanks to Ms. Lisa Romero of the Directorate Library and to Ms. Monica Closna from the HRTC staff. Ms. Romero was an invaluable source of information retrieval for the <u>many</u> documents I requested. Ms. Closna did an excellent job on the <u>many</u> revisions I made on my final report. Many thanks to both of you.

SUMMARY

In the majority of studies which have investigated individual versus small group achievement within the computer-based training (CBT) framework, there were no significant differences between the two experimental groups. Some studies produced significantly positive results, but no study produced significantly negative results. However, one would expect groups to outperform individuals. After reviewing the small group CBT literature, this paper suggests that in past studies the behavior of the students in the small groups has not been appropriately structured. Based on related traditional instruction research, it appears that guiding students' behavior/discussions following CBT may increase achievement. A reciprocal peer-questioning model is proposed to provide this type of guidance. This model is briefly described and research is suggested. Implications of this model for distance learning are also provided.

I. INTRODUCTION

Although most CBT initially adopted an individual study format (perhaps due to the belief that one student:one computer-as-teacher most closely approximates the assumed ideal setting of one student:one master tutor), recent CBT research has indicated that achievement is at least as great when students work on the computer in small groups of two or three. Moreover, small group CBT achievement has never been shown to be significantly less than individual CBT. This is an important finding because every review on the overall effects of CBT (versus traditional instruction, TI) has reported some negative achievement results from using CBT.

Consequently, the general consensus on small group CBT is that it does not decrease achievement and that it is therefore probably more cost effective than having students work CBT individually. However, the notion that small CBT groups might <u>increase</u> achievement has not been seriously suggested even though research from seemingly related areas (e.g., cooperative learning) would suggest that using more than one student on the computer might actually lead to higher performance.

This paper will discuss the use of small groups in CBT with the emphasis on achievement versus attitudes, interests, etc. First, a brief overview of CBT versus TI research will be given. This overview will rely on past literature reviews and meta-analyses. Second, the existing small group CBT literature will be reviewed with a focus on answering the specific question, "Why hasn't small group CBT produced higher performance than individual CBT?" Third, suggestions will be offered as to the small group CBT factors which might influence achievement. Comments on the applicability of the findings in this paper for distance learning will also be provided.

II. OVERVIEW OF CBT VERSUS TI RESEARCH

Several comprehensive CBT reviews have been conducted on the effect of CBT versus TI. In all of the studies reviewed, the computer was viewed as a <u>teacher</u>. This point is made to distinguish past computer use from a later suggestion which will suggest the use of the computer as a <u>student</u>.

These reviews suggest that CBT can produce a positive effect size (ES) of about 0.30 along with a reduction in course length of about 33 percent. Also, there is a general consensus that the CBT studies which produce the greatest gains are (a) three months or less in length, (b) in the lower grades, and (c) on relatively less complex tasks and less difficult courses. Kulik & Kulik (1991) is a representative CBT meta-analyses.

However, there are several cautions which must be discussed. First, most if not all of the studies reviewed were one time only studies; i.e., we do not have results of the impact of CBT over repeated offerings. Second, some CBT studies did not contain enough information to make definitive statements (see Hmelo, 1989). Third, most of the articles reported the efforts of CBT proponents; i.e., researchers who are interested in the CBT concept. We do not know the efficacy of CBT when it is conducted by some one removed from the original excitement of the new technique. Fourth, there has been a consistent discrepancy between published and unpublished results over the effects of CBT; unpublished reports have typically produced lower scores. Related to this issue is the lack of information about failed CBT projects. Fifth, about 25 percent of all CBT studies produced results favoring TI, although most of these studies were not significant. Finally, after several decades of CBT work, traditional instruction still remains the norm in our educational system. These cautions dilute somewhat the conclusions found in CBT reviews and meta-analyses.

III. THE USE OF SMALL GROUPS IN CBT

A review was conducted of 30 studies which specifically compared achievement between individual CBT and small group CBT. These studies are summarized in Appendix A. A major result from these 30 studies is that in no case did individual CBT produce statistically higher achievement than small group CBT. Small group CBT was at least equal to individual CBT, and in 11 studies (36 percent) it was statistically better. This result alone is evidence that small group CBT does not harm achievement. However, the fact that there was such a high percentage of insignificant studies warrants discussion.

In many of the no-difference studies, the length of the experimental session was either one session of less than 60 minutes or several sessions which totaled less than 120 minutes. For instance, in the Carrier and Sales article (1987), which is a frequently cited no-difference studies, the experimental session lasted about 25 minutes. A question arises as to whether any experimental manipulation can influence achievement in 25 minutes. Also, in most small group CBT studies, the dependent variable was measured with either a brief paper-and-pencil or computer-based multiple choice exam. For instance, in Makuch et al. (1991) the dependent variable was measured with a 16 item post test on which 54 percent of the individual CBT students made a perfect score. It would be difficult for any learning setting to improve on those results. These results suggest that if small group CBT does increase achievement, short multiple choice tests may not have the power to detect the increase, especially if the experimental session is also short. Some other dependent measure, such as task performance, may be necessary.

Several studies reinforce the suggestion that a single multiple choice test may not have the power to detect what was <u>learned</u> in a small group CBT setting. Dick (1963) had individual and paired students cover 28 units of CBT over a 10 week period. A short multiple choice post test produced no immediate difference, but a year later the paired students recalled significantly more material than did the individual students. A similar result was reported by Shlechter (1990). Stephenson (1992a) had individual and paired students work a CBT spreadsheet tutorial in three, 70 minutes sessions and measured two dependent variables: number of spreadsheet commands used and performance on a spreadsheet exercise. There was no difference in number of spreadsheet commands used, but the paired students scored significantly higher on the exercise. These results suggest that paired CBT produces a 'deeper' level of learning, a level which may not be detected by a short exam.

Paired students seem to spend longer in CBT, at least initially. Carrier and Sales (1987) and Makuch et al. (1991) reported that even though there were no achievement differences between individual and paired students, the paired students took longer to complete the training. In both of these studies, the experimental session was less than 30 minutes. A similar finding was reported by Okey and Majer (1976) for individual versus pairs in a three hour/2 session training class; however, groups of three or four were the quickest groups. Dick (1963) reported that paired students spend an average of 3.7 minutes more on each unit. Fletcher (1985) reported that groups took an average of nine seconds more for each decision made in a spaceship battle game. This author found that paired students spent longer on a spreadsheet tutorial during the first of three sessions but spent about the same amount of time during the third session. And Dossett and Hulvershorn (1984) found that over a week long class, paired students required less time than did individual students, a result also reported by Shlechter (1990).

For at least two reasons it seems logical that paired students should spend longer than individual students working on CBT. First, at the beginning of the CBT sessions, paired students have to take time to establish a working relationship with each other; individual students can immediately start the task. Second, during the course of the CBT sessions, paired students may take time to verbally interact with each other; individual students obviously have no one with whom to interact. Off setting these two suggestions is the possibility that paired students may keep on task more (and therefore be quicker) than individual students who have no one to socially motivate them.

There are studies which are methodological sound and which did not produce significant difference between individual and paired student; i.e., not all of the insignificant results can be attributed to methodological causes. For instance, Dossett and

Hulvershorn (1983) had USAF recruits in an electronic principles course spend a week of training using CBT. They found no difference on an end-of-week written examination, but paired scores were slightly higher.

Before departing the achievement dimension, a point should be made about the experimental design used in the three Johnson and Johnson studies listed in Appendix A. These studies were basically conducted under the cooperative TI learning model; i.e., they were designed more to study cooperative versus competitive modes than individual versus small group CBT. In the first two studies, four students were assigned to all experimental conditions, even the individual group. In the third study all conditions had groups of three. Therefore, even in the individual condition, students worked in groups; they were simply instructed to work alone. Instead of manipulating differences between individual and small group CBT, these three studies may have manipulated differences in the instructions given to different groups of students.

Overall, most of the small group CBT studies show higher, but not statistically higher, performance for pairing students. Many of the studies have one or more inadequacies, such as short experimental sessions or short multiple choice dependent measures. Finally, there is no evidence that pairing students lowers achievement.

Specific Small Group CBT Factors

The 30 studies listed in Appendix A, and additional studies listed in tables 1, 2, and 3 were reviewed for specific results discussed below.

Group Aptitude Composition

Group aptitude composition studies (table 1) investigate whether groups should be composed of students with similar or dissimilar aptitudes. Naturally, if groups are homogeneous in aptitude, higher aptitude groups will outperform lower aptitude groups (Stephenson, 1992b). For heterogeneously mixed ability groups, the results are less clear. Hooper and Hannafin (1988) reported that mixed high and low ability students seemed to produce improved achievement for low ability students without a serious detrimental impact on high ability students. However, Yeuh and Alessi (1988) found that ability level in mixed aptitude groups had no effect on achievement, and Hooper et al. (1989) found that heterogenous groups suffered with regard to achievement.

Table 1

GROUP APTITUDE STUDIES
(?=Unknown)

Bellows (1987)	triad mixed > triad same ($p < .001$); ns for dyads
Dossett & Hulvershorn (1983)	ns
Hooper & Hannafin (1988)	low-ability Ss performed better in hetero groups ($p <$?); high-ability Ss not harmed by hetero grouping (ns?)
Hooper et al. (1989)	ns
Hooper & Hannafin (1991)	ns
Yeuh & Alessi (1988)	ns

A problem with some studies which supposedly study the effect of aptitude pairing is that the population being used is relatively homogeneous. For example, Dossett and Hulvershorn (1983) studied United States Air Force recruits enrolled in an electronic principles training course. An airman must be highly qualified to attend that course. Therefore, these subjects were probably either very high or just high ability students; i.e, they all came from a homogenous group. The impact of mixed ability teams on low ability student achievement may not have been truly addressed in this study or for that matter in any study which uses a relatively homogeneous population such as, for example, college students.

At the heart of this issue is a desire to pair a low ability student with a high ability student and to have the high ability student's assistance produce disproportionately higher achievement in the low ability student than would have occurred if the low ability student had worked individually or with another low ability student. In one case, this result seems to have occurred, and in other cases it has failed to occur. It fails either because the low ability student gets overwhelmed by the high ability student's manner, etc., or because the high ability student does not care about helping the low ability student. In the first case, the low ability student simply withdraws and does not participate, and in the second case the high ability student leaves the low ability student behind. For mixed aptitude groups to work, the high ability student must be both willing to assist and also capable of assisting the low ability student. Also, the high ability student must perceive that assisting the other student will not harm his/her achievement.

Overall, the literature on aptitude composition of CBT groups is inconclusive. Related to the aptitude question are those studies which report that individual CBT seems to help high

ability students disproportionately more than low ability students (e.g., Stephenson, 1992a). Such results would question whether mixed ability teams would work efficiently, given that in isolation the high ability team member will benefit more from the CBT program than the low ability member. However, the aptitude grouping issue is probably highly interactive with subject material, software focus, aptitude differential, and course length.

Group Gender Composition

Another group composition factor is gender (table 2). The little work that has been done on this topic suggests that small groups (at least pairs) should be like-gender. Dalton (1990) found that heterogeneous groups of males and females scored lower than homogeneous teams, a result also reported by Underwood et al. (1990). Carrier and Sales (1987) reported that mixed gender teams engaged in more off-task behavior than same gender teams. This author found that mixed gender teams of college students were more socially oriented during CBT sessions. Bellows (1987) reported that when one child was dominant in a mixed-sex group, five out of six times it was the male. Common sense would suggest that age may play a role. Mixed groups of younger students (e.g., K-8) will interact much differently than older students (e.g., college students).

Table 2

GROUP GENDER COMPOSITION STUDIES

Bellows (1987)	in 5 out of 6 mixed groups, male was the dominant partner
Carrier & Sales (1987)	mixed groups demonstrated more off-task behavior
Dalton (1990)	same gender out performed mixed gender ($p < .05$)
Guntermann & Tovar (1987)	ns
Reid et al. (1973)	ns
	mixed pairs performed least well
Underwood et al. (1990)	same gender outperformed mixed gender ($p < .01$)

However, if the purpose of the CBT program is to develop face-to-face group skills, then the group must be mixed gender to reflect reality. It does not matter what the literature shows because the skill being trained in this situation is how to get along with others of the same and opposite gender. Therefore, there are situations in which mixed gender groups are required. If mixed gender is not required, same gender groups seem to achieve more.

Heterogenous grouping can be based on dimensions other than aptitude or gender. For example, students with similar aptitudes but with different experience levels on a computer could be paired. Or, students of like gender but with different motivational levels (e.g., grade point averages) could be paired. In fact, it would be difficult if not impossible to pair two students who are not similar on at least one dimension critical to CBT achievement.

Group Size

The size of the small group (table 3) has also not been thoroughly studied. Most studies have used two or three students per team probably because of the space limitations imposed by the typical microcomputer lab. Cox and Berger (1985) studied group sizes of one, two, three, and five; a significant difference was only found between individual CBT and the various small groups. However, the highest mean achievement and lowest standard deviation were found in the dyads. Guntermann and Tovar (1987) found no difference between individuals and groups of two or three, and Okey and Majer (1976) found no difference between individuals and groups of two and groups of three or four. Trowbridge and Durnin (1984) studied groups of one, two, three, and four and found insignificant results. However, pairs and triads seemed to be the best combinations. They noted that "Quads, however, seemed to be too large, in general, for all four members to maintain high levels of interactivity with either the program or with other members of the group (p. 12)". Bellows (1987) reported that four of 11 groups of three students each produced the "odd man out" syndrome. Finally, Webb's review (1989) of TI small group learning studies offers support for a group size of two. Overall, the limited amount of research in this area suggests that no more than three students can work effectively as a team in CBT and that two students may be the ideal number. On a related dimension, if group size is in fact two, much of the concern about group aptitude and gender composition is reduced.

Table 3

GROUP SIZE

Bellows (1987)	4 of 11 groups of 3 each produced "odd man out"
Cox & Berger (1985)	groups (2, 3, & 5) > individuals (p < .02); dyads had highest scores of groups (ns)
Guntermann & Tovar (1987)	ns (gps of 1, 2, & 3)
Okey & Majer (1976)	ns (gps of 1, 2, & 3/4)
Trowbridge & Durnin (1984)	ns (gps of 1, 2, 3, & 4)

In summary, the small group CBT literature is in agreement on the following:

(1) While small group CBT has not shown the same achievement gain and reduction in training time reported in TI-CBT reviews, small group CBT achievement is never significantly less than individual CBT.

(2) The CBT session should be long enough to allow the effect of small groups to occur.

(3) To properly detect the impact of small group CBT, at least one performance-based measure should be taken.

(4) Small groups should be either two or three in size.

(5) Some research suggests that groups should be same gender. However, there is no consensus on aptitude composition.

IV. SMALL GROUP CBT RESEARCH VARIABLES

Before discussing variables which could possibly affect achievement in small group CBT, several points should be made. First, a safe assumption is that few if any of the paired CBT studies had software written especially for small groups. Also, rarely do we know the aptitude focus of the CBT software used; e.g., we do not know whether the software was targeted for high ability students, low ability students, etc. Second, the physical arrangements of the paired students were not defined in the articles. A natural assumption would be that two or three students simply sat around a terminal configured for one operator and made do. Third, in most of the studies there were no instructions reported as to how the pairs were told to interact, were they told; who should use the keyboard, who should sit where, etc. And fourth, the role of the instructor was not operationally defined. Rarely does it appear that an attempt was made to re-configure the experimental setting to take advantage of whatever benefits small groups might have in CBT. Attending to relevant small group variables should only increase the probability that small group CBT achievement will be higher than individual CBT achievement.

Another background issue concerns the adoption of a small group CBT model. There is a strong desire to simply adopt the work done on small group TI cooperative learning (e.g., Johnson, D. W., & Johnson, R. T., 1989). However, small group cooperative TI and small group CBT are not interchangeable for several reasons; e.g., the group size limitations imposed by the typical CBT setting, the addition of the computer to the learning setting, the emphasis in cooperative TI learning on member roles, reward structure, group goals, etc. Moreover, the cooperative TI model is not as behavioral as might be desired. Although

cooperative TI learning has much to offer CBT, that body of research can not be transposed to CBT in wholesale fashion.

With the above as background, what are the small group CBT variables which could be manipulated to influence achievement? One obvious variable is the aptitude focus (high, medium, low, etc.) taken by the CBT software. Related to the software issue is the question of how do multiple students interact with the computer; do all students have keyboards, do all students key in responses, what happens when one or more incorrect responses are made, etc? Another research issue is the physical arrangement of the students while they are engaged in CBT.

With regard to these first three research questions, it should be noted that students like to touch the monitor while working CBT in pairs. Based on observations by this author, it is common to see one student working the keyboard while the other student points to and touches the screen. If both students are required to keyboard responses to the CBT program or if the physical arrangement prevents this type of 'hands-on' behavior, it could prove detrimental to achievement.

Two other research issues are group composition and group size. However, if group size is limited to two students, the impact of group composition, as well as the issues listed above, on achievement may be relatively small.

The role of the small group CBT instructor should be defined. Johnson, R. T. and Johnson, D. W. (1988) have suggested behaviors for the small group TI instructor; these suggestions may be appropriate for the CBT setting also.

Perhaps the most significant research issue for improving achievement in small group CBT comes from recent TI work by King (1990; 1991a,b), Pressley et al. (1988), Webb (1989) and others. These authors have chosen to focus on the small group member <u>behaviors</u> which seem to increase achievement. Student behavior may be the weakest link in small group CBT simply because most students do not have a history of working in groups. Therefore, small group CBT student behavior may be the area most receptive to improvement.

For instance, Pressley et al. (1988) found that when students answered "why" questions (e.g., "Why do women have more surgeries than men?") about to-be-learned facts, they learned the facts better than students who did not answer why questions. Evidently, the why questions guided the student's attention to what needed to be learned. In a sense, students were offered an elaboration before-the-fact and then asked to acquire specific support for that elaboration from material presented later.

Webb (1989) found that a student's achievement was related to the level of elaborative help that a student gives to other members of a small group. That is, elaborative help (e.g., how to solve a problem) promoted achievement in the help-giver, but non-elaborative help (e.g., providing facts) did not increase achievement.

King (1990, 1991a,b) trained students to create specific elaborative questions during review sessions. Students would then both offer their questions to other members of the small group to answer and also answer similar questions created by other group members. Students who used this technique had higher achievement than did students who just discussed the material in an unstructured manner. King proposed that the process of elaborating on and explaining material in a social context of reciprocal peer-questioning caused the material to be individually constructed; this knowledge individualization led to higher achievement.

King suggests that the critical factor in the reciprocal peer-questioning process is the stem of the question; i.e., the proper question stem will promote peer responses which are both highly elaborated and effective. In other words, to both create and answer elaborative questions, students have to go beyond a simple re-statement of the facts. In King's studies, students trained to ask these types of guided questions outperformed unguided questioners. Guided questioners both gave and received more explanations than unguided questioners and also gave fewer low-level responses (e.g., giving pat answers or facts). Examples of these types of questions are (King, 1991b):

"How are ... and ... alike?
"What is the main idea of ...?
"What are some possible solutions for the problem of ...?"

The ramifications of the reciprocal peer-questioning model for CBT are enormous, simply because the model suggests how small group CBT members should behave to maximize achievement. Within the CBT framework, this type of questioning could be build into (and initially taught by) the computer, as well as being made part of the students' behavior. For instance, at the end of the first training sessions, the software could offer guided question stems for to the students to complete and then present to other students to answer. As the students progress through the lessons, the creation of appropriate questions could be turned completely over to the students. The computer could record these questions and answers for evaluation by the instructor, thereby helping to define the role of the instructor in the small group CBT process.

This model incorporates two dimensions which seem to affect achievement. First, the model shows the individual small group

CBT student how to behave to maximize achievement: develop and answer elaborative questions. It should be noted that the model does not place any restrictions or offer any suggestions on how students should interact <u>during</u> the CBT session; rather, the model offers students guidance on how to best interact <u>after</u> the CBT session. Second, the model requires socialization. The model assumes that human socialization is an important aspect of learning and then structures that socialization into a form most conducive to learning in the small group CBT format.

Consequently, an important small group CBT research question is how to incorporate the reciprocal peer-questioning model into both CBT software and CBT student behavior. This model helps students reach the optimum behavior pattern versus hoping that they find it through trial-and-error. Again, it should be remembered that most students do not have a history of group behavior; i.e., they do not know how to perform in groups to maximize achievement.

If adopted, this model could also provide an umbrella to encompass several of the other research questions proposed earlier. For instance, the role of the instructor, group size, and the focus of the software are more easily addressed once the reciprocal peer-questioning model is adopted. Finally, the model could be easily tested using existing CBT software.

V. DISTANCE LEARNING

At the present time, there is no accepted definition of distance learning (DL) except that the student be physically separated from the instructor. CBT could certain fit or be configured to fit this definition. If CBT is to be treated as DL, a basic distinction must be addressed. Does the physical separation inherent to DL mean that the students are together but at a location separate from the instructor? Or does it imply that the students are also physically separated from each other? If the former is the case, then much of this paper's discussion on small group CBT applies to DL also. However, if the students are themselves separated from each other, then some of this paper's discussion on small group CBT may not apply to DL.

It would appear logical to assume that two students working at a computer in the back of the classroom (a typical small group CBT environment) is very similar to two students working at a computer in another classroom, as in distance learning. The main difference would be the potential for face-to-face student-instructor interaction. In the first case, the students would know that there is a possibility for face-to-face interaction with the instructor, while in the second case face-to-face interaction between the instructor and the student is not possible. Because there is no way to have the instructor be physically located at the DL site, this difference can not be

eliminated. Therefore, the reciprocal peer-questioning model should be tested in both settings: instructor present and instructor absent.

The applicability of the peer-questioning model is less clear for the DL setting in which team members are physically separated from each other. For instance, one requirement for cooperative TI learning seems to be considerable face-to-face interaction between the group members (Johnson, D. W., & Johnson, R. T., 1989). If group members are physically separated from each other, electronic interaction may or may not equate to face-to-face interaction. Also, physically separated group members necessitates that both have keyboards, monitors, etc. Such an arrangement eliminates the possibility of, for example, one member pointing to the screen while the other member's keyboards, although voice and visual interactions could still occur through appropriate links. Reciprocal-peer questioning could still take place, but it would not be face-to-face questioning. However, because the computer can still record the small group members' questions and answers for review and evaluation, the instructor can remain a part of the learning environment even in the physically separated DL setting. Finally, if electronic interaction (versus face-to-face interaction) is going to be the mode, group size could certainly expand beyond two. The model should obviously be tested in this DL setting also.

A final thought regarding this model for DL is related to the use of artificial intelligence (AI). Provided the AI technology were available, it might be possible to have an individual interact directly with an AI program capable of forming and answering elaborative questions; i.e., the computer would take the place of another team member. But, it must be emphasized that the computer in this suggested use would be acting like a <u>student</u> (<u>peer</u>-questioning) versus acting like a teacher. This approach is obviously radically different from the typical use of the computer-as-teacher. For those settings in which DL students are physically separated from each other, using the computer as a partner in reciprocal peer-questioning might prove just as productive as students interacting electronically. However, this approach would obviously eliminate all human interaction and therefore may be suspect, given recent CBT research.

VI. CONCLUSIONS

One would expect groups to outperform individuals in CBT, even though past research has not always shown this to be the case. This paper suggests that in the past the behavior of the students in small group CBT has not been structured to take advantage of the group setting. Based on related traditional instruction research, it appears that guiding students' behavior following CBT might increase achievement. A <u>reciprocal peer-</u>

questioning model is suggested; the model may provide the necessary student structure to increase small group CBT achievement over that produced in individual CBT. This model could be easily tested using existing CBT software. The model may also be applicable for distance learning, but certain configurations of that environment would require additional research.

REFERENCES

Bellows, G. P. (1987). What makes a team? The composition of small groups for C.A.I. A paper presented at the annual meeting of the American Educational Research Association, April 20-24, Washington, D. C. (ED37156)

Carrier, C. A., & Sales, G. C. (1987). Paired versus individual work on the acquisition of concepts in a computer-based instructional lesson. Journal of Computer-Based Instruction, 14, 11-17.

Cosden, M. A., & English, J. P. (1987). The effects of grouping, self-esteem, and locus of control on microcomputer performance and help seeking by mildly handicapped students. Journal of Educational Computing Research, 1(4), 8-16.

Cox, D. A., & Berger, C. F. (1985). The importance of group size in the use of problem-solving skills on a microcomputer. Journal of Educational Computing Research, 1(14), 459-468.

Dalton, D. W. (1990). The effects of cooperative learning strategies on achievement and attitudes during interactive video. Journal of Computer-Based Instruction, 17(1), 8-16.

Dalton, D. W., Hannafin, M. J., & Hooper, S. (1989). Effects of individual and cooperative computer-assisted instruction on student performance and attitudes. Educational Technology Research and Development, 37(2), 15-24.

Dick, W. (1963). Retention as a function of paired and individual use of programmed instruction. Journal of Programmed Instruction, 11(3), 17-23.

Dossett, D. L., & Hulvershorn, P. (1983). Increased technical training efficiency: Peer training via computer-assisted instruction. Journal of Applied Psychology, 68(4), 552-558.

Fletcher, B. C. (1985). Group and individual learning of junior high school children on a microcomputer-based task: Social or cognitive facilitation? Educational Review, 37, 251-261.

Guntermann, E., & Tovar, M. (1987). Collaborative problem-solving with Logo: Effects of group size and group composition. Journal of Educational Computing Research, 3(3, 313-334.

Hmelo, C. E. (1989/1990). Computer-assisted instruction in health professions education: A review of the literature. Journal of Educational Technology Systems, 18(2), 83-101.

Hooper, S., & Hannafin, M. J. (1988). Cooperative CBI: The effects of heterogeneous versus homogeneous grouping on the learning of progressively more complex concepts. Journal of Educational Computing Research, 4, 413-424.

Hooper, S., Ward, T. J., Hannafin, M. J., & Clark, H. T. (1989). The effects of aptitude composition on achievement during small group learning. Journal of Computer-Based Instruction, 16(3), 102-109.

Johnson, D. W. & Johnson, R. T. (1989). Cooperation and Competition: Theory and Research. Interaction Book: Edina, MN.

Johnson, D. W., Johnson, R. T., Stanne, M. B., & Garibaldi, A. (1990). Impact of group processing on achievement in cooperative groups. Journal of Social Psychology, 130(4), 507-516.

Johnson, R. T., & Johnson, D. W. (1988). Cooperative learning and the computer. In J. Ellis (ed.), AETS Yearbook: Information Technology and Science Education (pp 163-172). Columbus, OH: Association for the Education of Teachers in Science.

Johnson, R. T., Johnson, D. W., & Stanne, M. B. (1985). Effects of cooperative, competitive, and individualistic goal structures on computer assisted instruction. Journal of Educational Psychology, 77(6), 668-677.

Johnson, R. T., Johnson, D. W., & Stanne, M. B. (1986). Comparison of computer-assisted cooperative, competitive, and individualistic learning. American Educational Research Journal, 23(3), 382-392.

Justen, J. E., Adams, T. M., & Waldrop, P. D. (1988). Effects of small group versus individual computer-assisted instruction on student achievement. Educational Technology, 28(2), 50-52.

Justen, J. E., Waldrop, P. D., & Adams, T. M. (1988). Effects paired versus individual user computer-assisted instruction and type of feedback on student achievement. Educational Technology, 51-53.

Kacer, B., Rocklin, T., & Weinholtz, D. (1991). The impact of small group instruction upon attitude and achievement of student learning application. Computers in the Schools, 8, 357-360.

King, A. (1990). Enhancing peer interaction and learning in the classroom through reciprocal questioning. American Educational Research Journal, 27, 664-687.

King, A. (1991a). Effects of training in strategic questioning on children's problem-solving performance. Journal of Educational Psychology, 83(3), 307-317.

King, A. (1991b). Improving lecture comprehensive effects of a metacognitive strategy. Applied Cognitive Psychology, 5(4), 331-346.

Krein, T. J., & Maholm, T. R. (1990). CBT has the edge in a comparative study. Performance & Instruction, August, 22-24.

Kulik, C. L. C., & Kulik, J. A. (1991). Effectiveness of computer-based instruction: An updated analysis. Computers in Human Behavior, 7, 75-94.

Love, A. (1969). Individual versus paired learning of an abstract algebra presented by computer assisted instruction. (CAI-TR -5). Washington, D. C.: Office of Naval Research (ED034403).

Makuch, J. R., Robillard, P. D., & Yoder, E. P. (1991/1992). Effects of individual versus paired/cooperative computer-assisted instruction on the effectiveness and efficiency of an in-service training lesson. Journal of Educational Technology Systems, 20(3), 199-208.

Mevarech, W. B., Silber, O., & Fine, D. (1991). Learning with computers in small groups: Cognitive and affective outcomes. Journal of Educational Computing Research, 7, 233-242.

Mevarech, W. B., Stern, D., & Levita, I. (1987). To cooperate or not to cooperate in CAI: That is the question. Journal of Educational Research, 80, 164-167.

Okey, J. R., & Majer, K. (1976). Individual and small-group learning with computer-assisted instruction. Audiovisual Communication Review, 24(1), 79-86.

Pressley, M., Symons, S., McDaniel, M. A., Snyder B. L., & Turnure, J. E. (1988). Elaborative interrogation facilitates acquisition of confusing facts. Journal of Educational Psychology, 80(3), 268-278.

Reglin, F. L. (1990). The effects of individualized and cooperative computer assisted instruction on mathematics achievement and mathematics anxiety for prospective teachers. Journal of Research on Computing in Education, 22(4), 404-412.

Reid, J. B., Palmer, R. L., Witlock, J., & Jones, J. (1973). Computer-assisted instruction performance of student pairs as related to individual differences. Journal of Educational Psychology, 65(1), 65-73.

Seebo, Elane K. (1991). The comparative effectiveness of paired versus individual learning of cognitive skills using computer based instruction. Unpublished dissertation, University of North Texas, Denton, TX.

Shlechter, T. M. (1990). The relative instructional efficiency of group versus individual computer-based training. Journal of Educational Computing Research, 6(3), 329-341.

Shull, B. D. (1990). Your terminal or mine? Performance & Instruction, May/June, 37-39.

Stephenson, S. D. (1992a). The effects of student-instructor interaction and paired/individual study on achievement in computer-based training (CBT). Journal of Computer-Based Instruction, 19(1), 22-26.

Stephenson, S. D. (1992b). The effect of student-instructor interaction on achievement in a dyad computer-based training (CBT) environment. Journal of Educational Technology Systems, 21(1), 27-35.

Sutter, E. G., & Reid, J. B. (1969). Learner variables and interpersonal conditions in computer-assisted instruction. Journal of Educational Psychology, 60(3), 153-157.

Trowbridge, D. & Durnin, R. (1984). Results for an investigation of groups working at the computer. Irvine, CA: University of California, Educational Technology Center. (ED 238724).

Underwood, G., McCaffrey, M., & Underwood, J. (1990). Gender differences in a cooperative computer-based language task. Educational Research, 32(1), 44-49.

Webb, N. M. (1989). Peer interaction and learning in small groups. International Journal of Educational Research, 13, 21-39.

Whyte, M. M., Knirk, F. G., Casey, R. J., & Willard, M. L. (1990). Individualistic versus paired/cooperative computer-assisted instruction: Matching instructional method with cognitive style. Journal of Educational Technology Systems, 19(4), 299-312.

Yeuh, J. & Alessi, S. M. (1988). The effects of reward structure and group ability composition on cooperative computer-assisted instruction. Journal of Computer-Based Instruction, 15, 18-22.

APPENDIX A

RESULTS OF INDIVIDUAL VS. SMALL GROUP CBT STUDIES

(Positive=Paired Higher; ?=unknown)

AUTHORS	POST TEST RESULTS
Bellows (1987)	ns
Ages: 2nd graders	
Subj: map reading	
Time: one session (?)	
Carrier & Sales (1987)	ns
Ages: college juniors	pairs took more time
Subj: human taxonomy	
Time: one lesson (25 min)	
Cosden & English (1987)	ns
Ages: elementary grades	
Subj: math addition	
Time: 6, 10 minute sessions	
Cox & Berger (1985)	positive ($p < .02$)
Ages: 7th/8th graders	
Subj: problem solving	
Time: 3, 50 minute sessions	
Dalton et al. (1989)	positive ($p < .0001$)
Ages: 8th graders	
Subj: anatomy	
Time: 30 minutes	
Dick (1963)	ns
Ages: college students	pairs took more time
Subj: college math	pairs retained more
Time: 28 units over 10 weeks	
Dossett & Hulvershorn (1983)	ns
Ages: Air Force recruits (18-20)	pairs took less time
Subj: electronic principles	
Time: 1 week of class	
Fletcher (1985)	positive (p < ?)
Ages: junior high students	pairs took more time
Subj: spaceship battle game	
Time: one session (?)	
Guntermann & Tovar (1987)	ns
Ages: 4th graders	
Subj: Logo	
Time: one session (?)	
Johnson, D. W. et al. (1990)	positive ($p < .02$)
Ages: college freshmen	
Subj: map reading	
Time: 2, 50 minute sessions	
Johnson, R. T. et al. (1985)	positive ($p < .05$)
Ages: 8th graders	
Subj: map reading	
Time: 10, 45 minutes sessions	
Johnson, R. T. et al. (1986)	positive ($p < .05$)
Ages: 8th graders	

Subj: map reading	
Time: 10, 45 minute sessions	
Justen et al. (1988)	ns
Ages: college students	
Subj: exceptional children	
Time: 12 sessions (?) over one semester (?)	
Justen et al. (1990)	ns
Ages: college juniors/seniors	
Subj: statistics	
Time: 6 lessons (?)	
Kacer et al. (1991)	ns
Ages: college students	
Subj: computer applications	
Time: ? sessions over 3 weeks	
Krein & Maholm (1990)	positive ($p < .001$)
Ages: adults	
Subj: auditing	
Time: 4 hours	
Love (1969)	ns
Ages: high school students	
Subj: algebra	
Time: 5, 40 minutes sessions (?)	
Makuch et al. (1991)	ns
Ages: adults	pairs took longer
Subj: well construction	
Time: one session (20 min)	
Mevarech et al. (1987)	positive ($p < .09$)
Ages: junior high students	
Subj: Hebrew language	
Time: 2/3 sessions (?) per week for 2 months	
Mevarech et al. (1991)	positive ($p < .05$)
Ages: 6th graders	pairs retained more
Subj: mathematics	
Time: 2, 20 minute sessions per week for ? weeks	
Okey & Majer (1976)	ns
Ages: college students	pairs more time
Task: teaching concepts	
Time: 3 hours in 2 sessions	
Reglin (1990)	positive ($p < .01$)
Ages: college fresh/soph	
Subj: mathematics	
Time: 27, 30 minute lessons	
Reid et al. (1973)	ns
Ages: college students	
Subj: algebra	
Time: 80 minutes	
Shlechter (1990)	ns
Ages: Army soldiers	pairs took less time
Subj: military communications	pairs retained more

Time: 1, 2-5 hour session	
Shull (1990)	ns
Ages: adults	
Subj: time sharing	
Time: one session (?)	
Stephenson (1992a)	positive ($p < .02$)
Ages: college juniors/seniors	
Subj: spreadsheet	
Time: 3, 70 minute sessions	
Sutter & Reid (1969)	ns
Ages: college students	
Subj: problem solving	
Time: 2, 2 hour sessions	
Trowbridge & Durnin (1984)	ns
Ages: 7th & 8th graders	
Subj: light bulb	
Time: one session (?)	
Underwood et al. 1990)	positive ($p < .05$)
Ages: 5th graders	
Subj: language	
Time: one session (?)	
Whyte et al. (1990)	ns
Ages: college students (?)	
Subj: DOS commands	
Time: ?	